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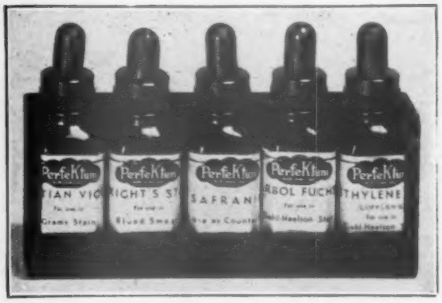

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The American Biology Teacher

Vol. 3 MARCH, 1941 No. 6

Lower Plants and Higher Education

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As members of this Association, we are united in our common interest in teaching Biology and in Biology itself. Yet, as we represent many widely separated localities and institutions, our approaches to this common interest are, of necessity, different. My own field of endeavor lies in the lower forms of plant life, and my teaching involves chiefly the guidance of graduate students doing original work for higher degrees in this field. Consequently, I chose this title on the general theory that a speaker really should know something of perhaps half his subject, for I do know a little about the lower plants, although twenty-five years have revealed to me how very little this is. Perhaps (a disquieting thought) I am becoming one of those super-specialists who goes through the paradoxical process of learning more and more about less and less until he reaches the logical end-point of knowing everything about nothing! Of teaching, I know still less, but twenty-five years have strengthened my conviction that therein lies the work I want most to do and have fostered the hope that sincerity, humbleness, and hard work, in endeavoring to arouse in others the interest and enthusiasm which I myself feel, may have compensated in part for lack of formal training in specialized educational techniques. Of education in its modern, streamlined, chromium-plated awesomeness, I know practically nothing — just enough to be amused but not unduly influenced by the saying that those who can, do; those who cannot, teach; those who can't teach, write books on education!

Being myself one of the lower organisms, and through long association with the simpler plants being accustomed to thinking of essential activities in simple terms, I cannot help regarding learning and teaching as natural and fundamental processes. For mankind, they have kept pace with evolutionary progress since before Pithecanthropus. For man as an individual, they begin with his first reactions after birth and cease only with his last consciousness.

Even the teaching of biology as part of modern curricula and educational programs should be essentially a simple and natural process, not the caricatured process of the translocation of the subject matter or stuff from the stuffer (or teacher) to the stuffee (or pupil), but rather the action of the teacher as a catalytic agent fostering the assimilation by the student, a living organism, of material which becomes a living part of himself. To be sure, this natural process is complicated by administrations and boards which apportion it into courses, semesters, and fields of concentration, formulate it into units, semester hours, or credits, bedeck it with diplomas and degrees, wrap it up in innumerable pink, green, and blue slips neatly tied with yards of red tape, labelling the whole a curriculum or system of education, yet despite all this, the process itself remains a simple and natural one. Its objective is likewise the simple and natural one of preparing the student not for college entrance examinations, but for life, and of equipping him not merely to earn a living, but to live.

The essential components of teaching biology seem to me to be the student, the subject matter, and the teacher. Let us, therefore, examine these essentials in more detail.

The Subject Matter

Two of these components, the student and the teacher, represent much the same pattern, and play in general the same part in any field of teaching. In Biology, however, the subject matter possesses certain preëminently advantageous qualities. It is the distinctive attribute of Biology, and hence the great boon to us, its teachers, that the raw material, the essential stuff of Biology, is the organism, the living thing itself. Thus knowledge may be acquired directly at first hand from the vital source by observation and by the experimental method, and not at second hand or even more remotely from records and interpretations worked over and reworked until far removed from their living origin. This is the unique glory and peculiar treasure of Biology. Only the paleontological branches of Biology lack this, and being deprived of living things as material, and denied the experimental method, must use, perforce, the imperfect and inadequate approach of such other fields of learning as History, which by their very nature are thus limited to the reconstruction and interpretation of material long dead. We cannot study the sensory reactions of Trilobites, nor the function of the endocrines of Dinosaurs, nor the action of plant hormones in Rhynia or Hornea any more than the historian can relive, recapture, and re-experience that vitality which made Greece in the time of Pericles of historic significance.

This vital nature of Biology is to us, its teachers, our strongest asset and advantage. It is also a responsibility and a challenge.

It rests with us whether we present the essential ingredients of nutritious and well-balanced courses in the manner of Biology, as living plants and animals, active, vital and functional, or whether we serve these ingredients in the manner of history as material, once living, but since then worked and reworked and repeatedly processed until it has come from the mill well seasoned, and neatly packaged for the consumer in handy volumes with attractive covers and colorful labels as Hormels High School Hash.

Another great advantage, characteristic of this, our subject matter, is that Biology is more nearly a participating subject than are most. Its very nature is such that the student gains knowledge of the essential fundamentals by taking

part in them. This inheres primarily in the fact that the two chief avenues of approach in biological learning are observation and experimentation. Other fields of learning also have these avenues of approach, but Biology imbues them with especial vitality and vividness, since they are the means by which the student, himself a living, functioning being, learns of the kindred functions and activities of other living things.

Of course, as in other fields, knowledge may be gained from books. museums, motion pictures, lectures and radio, but here in Biology, we may learn by direct observation of the living thing itself. That one look is worth a thousand words is especially true in Biology, whether Confucius said it or not. To observe a mushroom pushing up the bricks of a walk, the twining of the tendril around the twig, the clustering of motile algae on the light side of an aquarium, or the coöperative activities of a hive of bees, is to acquire a knowledge more effective, vivid, and lasting than could be gained in any other way. Fundamental biologic principles thus gained become a part of the student who gains them, for he has, in a sense, taken part in these phenomena. This learning through observation of the material itself is especially effective, for the mind of youth records with the completeness of a photographic plate the many details which the observation of youth gathers with the accuracy of a perfect lens, undistorted by any preconceived prejudice of what ought to be seen, and unfiltered and uncolored by emotional reactions. Thus, biological knowledge gained by the oldest and most direct approach, that of observation, is peculiarly effective in youth. To it can be added the adjuncts of orderly, accurate recording of the facts observed and subsequent deduction of general conclusions therefrom.

Experimentation, the second fundamental approach, is the other great asset of Biology. Experiments enabling the investigator to ask the questions of the material itself, rather than of the text or the teacher, can, of course, become a procedure involving extreme accuracy, great nicety of manipulation, and prohibitively costly apparatus, yet much experimentation, perhaps yielding really significant knowledge to Biology and certainly yielding information of vital value to the student, can be carried on with the simplest equipment easily manufactured or adapted from the wealth of stock available in those ubiquitous biological supply houses run by Woolworth, Kresge, and others. From such experiments, the students can learn not only biologic facts subject to experimental proof, but he can gain the fundamental principles of experimentation—to recognize the problem, to analyze its essentials, to formulate a procedure which will question the material so precisely that the answer will be conclusive. To these he readily adds additional principles such as the purpose of a "control" series for comparison with the experimental series. These principles, once grasped, are of incalculable advantage to the student's development. Thereafter, if he wonders whether a plant grows toward the light or away from the earth, he will more readily seek the answer from the plant itself through his own ingenuity, than from textbook, teacher, or other secondary source.

From these direct approaches so happily characteristic of biology, the student gains far more than the mere facts acquired, for the experience of gaining knowledge as a participant is so vivid that it has a powerful stimulating effect. Inevitably, his interest is aroused and the dynamic impetus of interest in learning is one of the pedagogical principles

recognized by even an outsider like myself. In some students, the realization that knowledge can be gained directly from the thing itself rather than from books or other sources is an awakening revelation of astonishing potentialities. I have seen students, apathetic in other courses, suddenly aroused to an almost fanatical zeal by the mere experience of growing a mold throughout its whole life history under constant microscopic observation. Yet, after all, this is wholly natural, for there is a fascination in watching the development of a plant from a dormant seed or of a microscopic mold from an inert dustlike spore; indeed in a sense, it enables the observer to participate in the miracle of creation.

It is in serving as material for direct investigation by students that the lower plants are especially valuable to the teacher. Their availability recommends them for they are everywhere. Their small size is a valuable feature for they are easy to manipulate and lend themselves readily to experimentation. It is unfortunate that most of the textbooks emphasize the higher plants primarily as laboratory material for, in many experiments, lower plant material can be employed much more satisfactorily.

The very minuteness of size which at first might seem a disadvantage in the case of such microscopic plants as bacteria, yeasts, molds and the like, is in reality one of their greatest advantages, for even a little contact with them and with their activities opens up to the student a world hitherto unknown and unnoticed. In every student there is the potential explorer. He longs to investigate the jungles of the tropics, to search out the farthest islands of the Pacific, and when he realizes that Biology gives him free access to realms as fascinating as the remote Amazon, yet in the nearest pond or ditch, and to forms of life as strange as tropical tree ferns and strangling figs yet sprouting from the mud of the nearest pond, his interest and enthusiasm, so vital in any learning, are aroused for the betterment of his course records and the enrichment of his life.

In these lower plants, processes of fundamental biologic significance and examples of the basic activities of living things in general can be studied to especial advantage in their simplest terms devoid of the complications inherent in higher plants and animals. Nutrition, for example, if approached with suitable bacteria, yeasts or molds as subjects and simplified laboratory experiments as procedure can be reduced to simple terms that will give the student at least a qualitative idea of what substances are not used, what are used and what products and by-products are the result. In like manner such fundamental activities as respiration, photosynthesis and growth are not only more easily understandable to the student in terms of lower plant material but also form a fundamental basis for later interpreting the more complicated processes in higher organisms. Reproduction, reduced to its essential feature, namely the means by which organisms perpetuate themselves, may be especially effectively approached through the lower plants and an understanding of the effective devices by which they achieve survival by rapid increase in numbers and by persistence and resistance through drought, freezing and other unfavorable periods, forms an excellent basis for understanding the more complicated methods of achieving the same ends in higher forms. Even sexual reproduction, present in many of the lower plants in simple, almost diagrammatic outlines, can be studied to especial advantage as a means of understanding the general principles involved, free from the emotional connotations that

may color such study in higher forms.

The Student

Although the subject matter of Biology possesses certain distinctively favorable attributes, the student, unfortunately, often does not. As a factor in the teaching of biology the student comprises certain components: namely, background of knowledge, ability, and attitude. Above all he is distinctly a complex organism. Indeed, it is biologically anomalous to lump him in one species, *Homo sapiens*, for although there are perhaps 125,000 species of lower plants differing markedly in structure, and in modes of life, yet they represent no greater diversity than the differences in character comprised within the single species, man, ranging from the Archbishop of Canterbury to Al Capone, from Pasteur to politicians, from Hippocrates to Huey Long. While such an extreme range of diversity probably will not be represented among our students, yet there will certainly be differences enough to influence our teaching.

Their background of knowledge you must take as it comes, for there is nothing you can do about it now. This is but one of the variables that make teaching so fascinating and require such adaptability on the part of the teacher. Their innate ability you can change little if any. Some have the potentialities of future Pasteurs, some might well be classed as "dead end kids," the cranial end being dead from the neck up so far as you can determine. Yet do not feel that only some of your high school classes have their problem children, for even the supposedly higher institutions of learning have their share. Indeed, there has been at least one beside myself on every faculty on which I have served! However, the third factor, namely their attitude, you can influence, for it is controlled in large measure by their interest, and in Biology we have especially advantageous opportunities for arousing the student's interest and enthusiasm, devotion to work and loyalty to the ideals of science. Indeed, I sincerely believe that toward the objective of training students for life, one can be more successful with a Biology class of inadequate background and medium intelligence than with a class of superior background and high intelligence in some other fields, chiefly because, through the peculiar advantages of your material, you can influence the attitude of the students and secure their interest, enthusiasm and coöperation.

The Teacher

The final factor involved in the teaching of Biology is ourselves. Like the students—and we were they not so very long age—we comprise three components, namely—background of knowledge, ability to teach, and attitude, but in our case all of these are within our control. Our knowledge, surely, is not finished nor static, for the many sources of its renewal and increase are available to us and especially the material itself, the source most vital and immediate, is ever present. All of us have had the experience of teaching a course for which, at the beginning, our background of knowledge was not wholly adequate and all of us know the stimulus and challenge of such a situation and realize that it is possible to keep up with the requirements of the class by burning the midnight oil according to the biblical adage, "day after day uttereth speech and night after night showeth knowledge." Our ability to teach we can improve also, for that too is within our control. Among you there are undoubtedly some who represent that rare and gifted person, the natural, born teacher, but most of us are but average or even less at first. Yet if we devote

ourselves to teaching with humbleness, sincerity and singleness of purpose, we cannot help but improve as years go by whether we had all the advantages up through higher courses in education which teach us how to teach teachers of biology how biology should be taught, or whether our equipment is a knowledge of biology itself, a sympathetic attitude toward those who seek to learn and a willingness to work unceasingly toward helping them acquire knowledge.

Our attitude as teachers is also within our control. The keen interest, the contagious enthusiasm, the indomitable resourcefulness, the untiring patience and the saving humor are expressions of ourselves, and sympathy, honesty and sincerity are of our essence. Whether these are the result of a suitable endocrine balance or are of the spirit, I do not pretend to know, but I do know they are essential in real teaching. I know also that the students are studying the teacher quite as much as the subject and that while you, with a class of twenty pupils, are trying to understand those twenty, to twenty you are a single subject for searching analysis and critical appraisal. When you are talking to the class there are two streams of communication, one the subject matter of your spoken words, the other that secondary stream of communication through which, in expression, gesture, intonation, and other subtle ways, you are revealing yourself to the students. By this secondary stream they appraise you and while you are explaining photosynthesis, they have grasped not only the explanation of that process, but also that they trust you, that they are ready to be cooperative, and that you are the sort of person with whom they like to work.

These three components, background of knowledge, ability to teach, and attitude, are thus within our control, but even the teaching of so fascinating a subject as biology is not achieved without the expenditure of energy. Consequently we are not actually the catalysts which I postulated earlier, for a catalyst is not used up in the process it furthers, nor, on the other hand, are we merely semi-permeable membranes that ultimately become clogged up by accumulations of transmitted material. Rather we are human beings, vulnerable to fatigue and to illness, to worry and to depression. As a result there is perhaps no profession in which one reaches greater depths of discouragement than in teaching. There come times, particularly in November and in March, when, awakening at three, your sense of inadequacy and failure becomes disproportionately overpowering and the chrysalises of doubt and discouragement give forth the black butterflies of absolute despair. Fortunately there are antidotes for this, the inevitable reaction from the work to which you devote yourself and into which you pour your enthusiasm and strength. Some find antidote in creative work of their own, whether it be investigation or handicraft. Others find their best antidote in sharing their problems with others and toward that end this association with its publications, its local and general meetings, is certain to play a very valuable and significant part. To others, the most helpful antidote is a change of environment and we are fortunate that our work, even though it demands so much, gives, in compensation, vacations that permit wholesome and restoring changes of scene and activity. It was my good fortune a few years ago to spend some months at the biologic station on Barro Colorado Island in Gatun Lake and while there I not only found new strength myself but saw teachers, in a few days close contact with that jungle rich in plant and animal life,

gain new resources for the work to which they would soon return.

In Biology, then, while the essential process of teaching, as in other subjects, involves the subject matter, the student and the teacher, we are peculiarly fortunate in the character of our material, not only because it permits acquiring knowledge directly from the vital things themselves, but also, finally, since we ourselves are living creatures, because the subject and the teaching of it are peculiarly close to student and teacher alike. Thereby we gain not only facts but also principles and attitude and a point of view. An insight and understanding of the biological significance and fundamental processes in biology helps to give us perspective, balance and sense of proportion and these are basic materials for life. We, with the students, thus gain an equipment for living, for life is a biological condition, its problems are primarily biological problems aiding us in learning how to adapt ourselves to conditions or how to change conditions to meet our needs, helping us to coöperate in working together for the good of all, aiding us in meeting the requirements imposed by the necessary division of labor in community activities without becoming overspecialized and narrow. We, with our students, come to realize that we are living things, part of the great stream of life, dependent upon plants and animals for food, possessing bodies whose successful functioning, activities, and defenses against disease are essentially like those of other organisms whose successful adaptation to conditions demands maintaining a balance with the world in general and with our fellowmen and other living things in particular. From the biological point of view, it is the human consequences involved in war that are significant rather than the political, geographical and territorial results. Finally, since we realize that the abuse of Biology, as of all science, endangers the welfare of mankind, we should determine that so long as we are its teachers we will never suffer Biology to be misused for the purposes of perverted propaganda or oppression.

Protozoans Are Not Simple Animals

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Many textbooks characterize protozoans as simple animals and the notion is very widespread, not only among students but also among teachers of biology. Because they are probably ancestral to the metazoans, it may suit our purpose from an evolutionary viewpoint to regard protozoans as elementary cells. At present students enter the college level with this erroneous idea firmly fixed in their minds and, unfortunately, many depart sadly unenlightened. While it is clearly impracticable to present the details of protozoan anatomy in the high schools, it should be possible to design instruction so that students will be aware that the relatively simple forms they are privileged to see are only introductory to a very diversified and complicated group of organisms. A brief survey of the history and present status of the group will show that any other position is untenable.

Those who enjoy historical backgrounds note time and again that history repeats itself, not only in events, but also

in ideas. So much so that it is very difficult to credit any one man with an advance in thought, it being needful only to go back to a preceding era of similar interests to find the germ of it already present.

In the "organismal" era which drew to a close about one hundred years ago Ehrenberg described protozoans as complete animals. The analogies he drew of them are understandable and intriguing, but have proven fallacious. Contractile vacuoles he regarded as beating hearts. Radiating canals were pulsating blood vessels. The macronucleus was the gonad. Food vacuoles were stomachs, of which the organism conveniently possessed one or many, according to its appetite. Concepts of this sort were, of course, in accord with the then fashionable belief in embryo preformation. Embryologists were fascinated by the thought of a complete individual in miniature within the germ cell, and their will to believe made up for many a detail which their eyes, through microscopes already efficient, could scarcely have seen. Some sketched the organism within the egg, but others with equal assurance saw it within the sperm. Only to those familiar with the only-little-less than divine microscopic visions sometimes made apparent to our beginning students, can such observations be anything less than completely incredible.

With the general acceptance of the Cell Theory, protozoans were relegated to the status of simple free-living cells comparable to the supposedly uniform and uncomplicated building blocks of metazoan animals. It is interesting to note that in the minds of philosophical biologists the Cell Theory resulted in a brilliant progress of scientific thought. but that as usual, the inertia of the pendulum carried it wide of the central basis of fact, as we see it today. The organism is now regarded as more than the sum of its parts. In cytology smaller and more fundamental units of structure than the whole typical cell have come to light. In embryology we have slowly returned to the idea of a preformed embryo within the egg; but from the viewpoint of localized potencies rather than visible structures. Similarly, the status of the protozoans has again changed. Protozoans have emerged as something very much more than simple, free-living single cells.

What is a protozoan?

Before 1675 apparently no one was aware of the existence of microscopic life. In April of that year, Leeuwenhoek, with inveterate curiosity and an eye for detail, saw and described Vorticella as one of the "Infusionsthiere" he found in a little rain water which had accumulated in a small earthenware vessel "glazed blue within." The Infusoria (derived from Infusionsthiere) at that time included almost all small forms of animal life. Even in 1838 Ehrenberg included rotifers, small crustaceans and worms with the protozoans. On the other hand, up to 1835 when Dujardin established their true position, Foraminifera and Radiolaria were regarded as minute molluscs. Slowly our present-day categories were established. In 1866 the Mastigophora were so named by Diesing and in 1889 Bütschli named the Sarcodina in honor of the "sarcode" of Dujardin. This marked the completion of the first clear taxonomic conception of the major groupings of the protozoans, in which some 15,000 species are now known.[1]

Morphological and physiological data have accumulated together with, and as

[1] Unfortunately the names of some of the commonest have recently been opened to dispute. I have observed with distress the over-zealous application of the taxonomists' "Law of Priority" to such common generic names as Amoeba, with the resulting "Chaos."

the basis of, taxonomic progress. With present information it is possible to re-evaluate the group known as Protozoa. A survey of this remarkable category of animals shows that protozoans may consist of one cell or of many cells. In one cell there may be one or many nuclei. The nuclei may all appear to be similar, as in Opalina, or sharply differentiated as in Paramecium. Many-celled protozoans may consist of similar cells as in Synura and Gonium or the cells may be differentiated within the colony as in Proterospongia and Volvox; or differentiated in the life history as in sporozoans. In size a protozoan may be very small and active as Chilomonas or Halteria; or it may take the form of a sheet of slow moving protoplasm several feet in extent, as in some mycetozoans.[2]

While superficial examination of the common laboratory protozoans may support a simple view of the group, a more rounded knowledge reveals glimpses of an amazing intracellular complexity. The shells of foraminiferans are in some respects fully as complicated as those of the molluscs, with which they were once thought to be affiliated. The skeletons of radiolarians are a marvel of engineering and artistic design, unsurpassed within the animal kingdom. Nor are such phenomena as bilateral symmetry, dorso-ventral differentiation and metameric arrangement of parts usually attributed only to the higher animals, unknown among the protozoans. Professor Kofoid, in the Proceedings of the National Academy of Sciences, volume 21, number 7, described two ciliates of the family Ophryoscolecidae manifesting all of these properties; which are shown also by members of other groups, as for example in Polykrikos, a dinoflagellate. And in accord with the high level of organization indicated in these ways there has been demonstrated in a number of forms an exceedingly intricate coordinating mechanism, the neuromotor system, which resembles the nervous system of some of the higher animals.

Protozoan life phenomena also parallel those of higher animals. In nutrition they may show indiscriminate feeding as in Paramecium; specific carnivorousness as in Didinium; occasional cannibalism as in Blepharisma; endoparasitism as, for example, of the suctorian Sphaerophrya within Paramecium. In their reproductive cycles they may manifest maturation phenomena, bisexuality (which was recently demonstrated by Sonnenborn with Paramecium) and alternation of generations as in Polystomella, Plasmodium and others. In their embryology they sometimes show recapitulation, as in the ciliated larvae of Suctoria.

Although individual protozoans are all comparatively small,[3] in aggregate they form appreciable masses. Euglena often colors fresh water. A bloody red color of water and snow is said to be due to Haematococcus. *Noctiluca scintillans* by day imparts a tomato color to the sea and at night is responsible for brilliant luminescent displays. After death[4] protozoans leave remains for us to see. In Mississippi and certain other of our Southern states, the graveyards of the foraminiferans are in places piled up in the form of chalk beds 1,000 feet thick,

[2] Botanists claim this group under the name Myxomycetes; as they do also the Phytomastigina. I do not believe taxonomic clashes over necessarily amorphous border lines are of any real value.

[3] The largest single-celled form I know of is Porospora gigantea, in the lobster's intestine. See "Giants among the Invertebrates," *Teaching Biologist*, February, 1937.

[4] Strictly speaking, there is no death in most protozoans. See "A Brief Review of Death," *Teaching Biologist*, April, 1938.

a fact interesting not only for itself but because of its geological significance. Some protozoans impinge themselves upon human senses other than that of sight. Uroglena, Dinobryon and Synura occasionally become numerous enough to impart an oily, fishy or cucumber-like flavor to our drinking water. A few which enter our mouths find the human intestine a suitable place to live. *Entamoeba coli* seems to be a harmless wanderer, but *E. histolytica,* Giardia and Balantidium may produce marked disturbances. Found also in the human body, but gaining entry by inoculation, are several extremely important forms. Among these is Plasmodium, the cause of malaria, regarded as the most devastating human disease. In India it is responsible for one million deaths per year and throughout the world for half of all deaths.[5] While not so widespread, *Trypanosoma gambiense* is credited, in certain sections of Africa, with wiping out two-thirds of the population in six years.

With a realization of all these things —the complexity of their structure, the intricacy of their life cycles, their diversified habits, the width of their distribution—our concept of the protozoans is changing. We are tending to recognize them as a sub-kingdom which, to a degree, parallels the metazoans in pattern of basic structures and life phenomena. It differs mainly in the direction of its evolution which has, of course, been conditioned by the small size and lack of cellular organization of most of the constituent members.

In the 17th century Leeuwenhoek wrote, "How marvelous must be the visceral apparatus shut up in such animalcula." Today we realize how close to the truth this speculation really was. From an evolutionary viewpoint, nothing could be more logical, inasmuch as protozoans comprise a group of most ancient lineage and have been subject to long action of evolutionary forces. Indeed, today, the concept of protozoans as non-cellular (rather than single-celled) organisms of great complexity is already somewhat of a truism.

Protozoans are not simple animals.

[5] Chandler, A. C., *Introduction to Human Parasitology,* 5th edition, p. 164.

USING STUDENT INTERESTS TO MOTIVATE AND TO DEVELOP ABILITIES

The article, "An Interest Survey in Biology," by J. W. Galbreath in the November issue of "THE AMERICAN BIOLOGY TEACHER," prompted me to tell how student interest has been used for the past few years in our classes.

About the beginning of the second six-weeks-period a rather long list of topics is put on the blackboard or bulletin board or copies are handed to students. It is explained that each student is to choose a topic for detailed study. A written report is expected of everyone and in most cases an oral report is required. It is obvious that long units must be separated into topics and where some require little time the student is asked to report on two or more. Two or more students may work together but each must be responsible for a definite piece of work.

While we proceed with our regular work a week or more is given for choice of topics to be made. So that all may understand the nature of the material involved such topics as heredity, fossils, and eugenics, are discussed and explained. Topics suggested by the students may be used if such topics seem at all related to the subject.

The next step is to bring to our room

suitable reference material from the library and home so that students may work under supervision. The teacher furnishes some reference material and suggests others and in some cases letters are written for material.

Students are shown how to use indexes and table of contents, how to take notes, how to make a working outline and later how to organize and write this material into a report. Any needed experiments or investigations are provided for.

The teacher moves around the room, which is now like a workroom or library, checking and encouraging. Part of each period is used for general suggestions and questions and for brief reports on progress.

To avoid monotony two or three days a week are used to carry on some unit in the conventional manner since some topics are best treated that way.

Students are expected to go over their material with the teacher a few days before reporting and are to use the blackboard, charts, pictures and demonstration material and any other means to put across the report.

The instructor supplements the student's report and the class takes notes. There is opportunity for questions and discussions and finally the person reporting gives a summary of the main points to be remembered for tests which come later.

Some of the outcomes are:

1. Interest is assured because pupils choose their own topics.
2. Experience is gained in collecting and using reference material.
3. Practice is given in taking notes and in using the notes.
4. Students learn to select the main points from a large amount of reading.
5. Students learn how to organize material and write it into a logical and interesting report.
6. Experience is given in presenting material to classmates which includes the use of various aids to teaching.
7. Life long interests may be developed by detailed study of one subject.

Not all results are good but some reports show surprising ability. For example some boys studied tobacco and wrote a fine report which included history, use and harm. One of the boys said, "I'll never use tobacco again."

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Central High School,
Superior, Wisconsin.

THE TORSO MODEL

A bit of equipment that should be in every biology classroom is a torso model. I realized that many things could be done with this aid that were impossible with any other piece of equipment, therefore, I was enthusiastic to have this model for our department. The success of the model (sexless type) has far exceeded my greatest expectations. This aid aroused interest and answered questions so easily, that, it paid for itself in one year. The model is constructed of material that can be washed and is not easily broken, if handled with reasonable care.

For students as visually minded as those of today charts are a wonderful aid, but models add another phase to this visual reception by being in third dimension. Models are superior in representing relative positions of structures and in showing clearly the relationship of the various systems of the body.

Helen Towbridge,
Glenbard Township High School,
Glen Ellyn, Illinois

President's Page

WHAT'S ALL THE SHOUTING ABOUT?

Some years ago a character in a popular Broadway production achieved distinction by continuing to rush on the stage and interrupt the other actors with the question: "What's all the shoutin' about?" I feel like asking the same question with reference to the multitude of rumors that were making the rounds of the hotel lobbies in Philadelphia whenever science teachers got together. I believe our members would like to know the nature of those rumors—in fact, should know.

It appears that The National Science Committee which has been working for the past two and a half years under the chairmanship of Dr. Ira C. Davis of the School of Education of the University of Wisconsin is about to bring in a recommendation to the effect that a National Science Council, such as the present Social Science Council, be set up. It is hoped that an agreement can be worked out between The American Association for the Advancement of Science on the one hand, and The National Education Association on the other, whereby this council could combine (and control?) the functions of all existing science teaching organizations. The council is to have a paid secretary with permanent offices in the National Education Association building in Washington, and is to publish a journal devoted to all phases of science teaching from the elementary grades through the teachers colleges.

Exactly how existing science teaching organizations, such as *The National Association of Biology Teachers,* are expected to fit into the proposed scheme has not been made clear. That is, whether associations such as ours will affiliate with the council, or whether they will be expected to "close shop." The Department of Science Instruction of The National Education Association has already signified its intention of going out of business. It is reported that an important official of The National Science Committee made an address at Slippery Rock, Pennsylvania, last autumn in which he stated that the council is prepared, if need be, to take away advertising from existing science teaching magazines in order to force them into line. This would appear to be a poor method of procedure.

It is to be regretted that the national committee did not see fit to approach the N. A. B. T. with some sort of proposition for consideration at our meeting in Philadelphia. A tentative constitution is already in existence and was considered by some groups at the Christmas Meeting, groups with only one-tenth the membership of the N. A. B. T., and yet no copy of this constitution was received by any of our officers. I know, too, that at least one of these groups found the plans so nebulous that it did not feel warranted in giving a vote of approval right then. The National Science Committee could hardly fail to notice, both in our journal and on our stationary, that we are associated with the A. A. A. S. and thus will not have another opportunity to discuss the matter until next Christmas. 'Tis true we have had a representative on the National Science Committee, but she was forced to become inactive on account of illness, and the board has asked your president to represent our association at the forthcoming meeting of the committee in Atlantic City.

I believe I bespeak the sentiments of our entire board when I affirm that *The National Association of Biology Teachers* will be very happy to work with any council dedicated to the improvement of science teaching, but we are only human and do not relish being slighted. We have been put into the position where we are almost certain to be the last group to vote on the matter and we are likely to be charged with failure to cooperate. We deplore our inability to get hold of a copy of the constitution so that we could discuss the question at our two-day board meeting. Thus in this letter I have been forced to resort to rumor. I hesitate to believe that an organization of more than two thousand members was intentionally overlooked, because if there is any intimation of employing the "führer" technique to accomplish objectives, however worthy, the council is doomed to failure because it already has been inoculated with the very germs of failure.

Let's wait and see, is the attitude of *The National Association of Biology Teachers.*

P.S. I have just returned from Atlantic City [Here was held the meeting of the National Science Committee, on which Dr. Jeffers is our Representative] and the situation is not so bad as I indicated. These are genuine rumors that I reported upon, but they are either greatly exaggerated or those in authority have moderated their position quite a bit. At any rate I see no danger now of a conflict arising between the new National Council and such organizations as ours.

G. W. Jeffers

The National Audubon Society announces that it will conduct the Audubon Nature Camp for Adult Leaders for its sixth season during the summer of 1941. The Camp is located on a spruce-covered island in Muscongus Bay, Maine, about sixty-five miles northeast of Portland.

The Camp was established for the special purpose of providing teachers and youth leaders with practical programs for nature study, adapted to their individual needs, and to offer opportunity to observe living plants and animals in their natural environment. Young, experienced specialists conduct a program of field classes in birds, plants, insects, water life, and nature activities. Visits are made to a variety of habitats including evergreen forests, hardwood forests, salt water shores and marshes, fresh water ponds, open meadow and outlying oceanic islands.

Campers may enroll for one or more of the following five two-week periods:

June 13 through June 26
June 27 through July 10
July 11 through July 24
August 1 through August 14
August 15 through August 28

During the past five summers, 985 persons from 37 states and 4 Canadian provinces have spent 1146 two-week enrollment periods at the Camp. The Camp is operated at cost. For illustrated circular of information write: Camp Department, National Audubon Society, 1006 Fifth Avenue, New York, N. Y.

The Western Regional Meeting of the Junior Academy of Science of Pennsylvania will be held at Scottdale High School, Scottdale, Pennsylvania, on Saturday, April 5, 1941. Members, as well as high school science students not now affiliated, are invited to attend. They are offered an opportunity to present papers of their own if they will contact the Club of Scottdale High School or J. Mendel Hirst, the club sponsor, at once.

Know Your Feet

WILLIAM A. BETTS
The Senior High School, Austin, Texas

Nature has prepared from a mass of bones, skin, muscles, ligaments, nerves, tendons, and blood vessels a foundation for the human body—a pair of feet. On an average this body foundation transfers daily from one point to another a weight of more than a million pounds. The human foot, however, was not fashioned to withstand the impact of hard floors and pavements. If the feet were bare at all times and contacted only soft earth, it is doubtful if foot ailments would occur. These ideal conditions do not exist; hence, foot troubles do exist.

Foot health is of great importance to man. Lincoln once remarked: "I cannot think if my feet hurt me." Defective feet may prevent a citizen from serving his country in time of war. Millions of men were called for military service in 1917, and 80 per cent of those who failed to pass the physical examinations were rejected because of defective feet. During the 1940 summer maneuvers of the National Guard, news items revealed that many men were forced to drop out of action because of feet "that couldn't take it."

Since medical authorities estimate that 90 per cent of the population suffer from foot troubles at some period of life, it seems that boys and girls need to know more about foot health, footwear, and home treatment of foot troubles. Because they possess the proper scientific background and equipment, biology teachers can give their students this information. It would necessitate the elimination of some functionless materials already in the curriculum; however, the progressive biology teachers, and certainly their students, would grieve little at their going.

A knowledge of foot construction and function is prerequisite to intelligent care of the feet. Since ordinary mortals are prone to regard the feet as mere pedal extremities, a study of the feet from a biological viewpoint should make the student foot-conscious. There are 26 bones in the normal human foot. These bones form several arches, only two of which will be mentioned here. The main longitudinal arch extends from the heel to the ball of the foot. It is called the "pedal shock-absorber." The anterior arch is formed by the heads of the metatarsal bones in the forefoot and extends from the inside to the outside of the foot at the ball. The bones of the foot are held together and in proper position by numerous ligaments and cords which criss-cross among them. All foot movements are controlled and powered by muscles in the leg which are connected to the bones of the foot by long tendons. The large tendon at the back of the heel connects the calf muscles with the foot. Anatomists believe that human feet were designed for these purposes: 1) to form a three-point support for the weight of the body, 2) to absorb the shock of impact which would otherwise be sent higher to the organs in the torso and the brain and cord, and 3) to deliver the power for propelling the body. Shoes should be designed to help the feet perform these intended functions.

Misfitted or improperly designed shoes instigate most of the foot ills of mankind. It has been aptly said that tight shoes have one virtue—they make

one forget all other troubles. One should take time and exercise discretion when buying shoes. It is possible to purchase snug-fitting as well as fashionable footwear. Feet should be measured when all of the weight of the body is on them. This technique tends to forestall the purchase of shoes that are too short. It is essential that both shoes fit well. A shoe should feel comfortable even when all of the weight of the body is thrown on one foot. Shoes that have to be "broken-in" before they become endurable should never be purchased. No shoe is a bargain if it is uncomfortable, and cheap shoes are most expensive in the long run. The practice of buying shoes in bargain basements and from mail-order houses should be discouraged.

If nature had intended that the heel be elevated three or four inches above the level of the ball of the foot, she would have designed the foot differently. Heels higher than 1½ inches should be avoided. High heels may cause the muscles at the back of the leg to shorten; hence, when lower heels are worn the heel cord and muscles will be so stretched as to cause discomfort or even pain. High heels weaken the ankle ligaments. They throw the entire weight of the body upon the ball of the foot, thus straining the anterior arch. Nature intended that the weight of the body should be distributed over three areas; namely, the heel, the outside, and the ball of the foot. High heels are not, however, to be utterly condemned. They are designed primarily for dress occasions. If low-heel shoes are worn at other times, it is not likely that foot ills will result.

Correctly-fitted shoes will not forestall foot troubles if one wears hose that are too short. Stockings or socks that are too short will in time cause ingrown nails and induce the formation of large joints and bunions. Hose should extend ½ inch beyond the longest toe. Foot health will be enhanced if hose are changed daily and washed in boiling water that contains some boric acid.

For many years the men in our army and navy were taught to stand and walk with their toes turned out. This misinformation is still handed out in some public schools. One should walk and stand with toes straight ahead. While standing, it is important to keep the ankles straight and to throw the weight of the body on the outside of the feet. In walking, the body should be jarred as little as possible; hence, pounding of the heels should be avoided.

Flat feet result from fallen arches. The term "broken arch" which is often applied to this condition is a misnomer. The relaxation of leg muscles allows the foot arches to sag or fall. Occasionally persons are born with flat feet and never suffer therefrom. As a rule, however, when the bones of the arch are lowered they pull and strain the many ligaments and cords which are interspaced among them, an action which results in pain sensations for the owner of the feet. Sagging arches often cause pain in parts of the body remote from the feet. Some of the fundamental causes for fallen arches are: 1) misuse of the foot, 2) failure to exercise leg muscles, 3) wearing of badly-designed or poorly fitted shoes. Women's shoes frequently have concave-shaped soles. This type of shoe causes flattening of the front or anterior arch which extends across the ball of the foot, the first warning of which is pain in the outer three toes and directly under the ball of the foot. Arch strains are slow to correct and a foot doctor should be visited at the first sign of such trouble.

Corns are the result of friction and pressure of badly-fitted shoes or hose, and a permanent cure cannot be effected

without the elimination of these fundamental causes. Commercially prepared "corn cures" contain powerful skin disintegrators and should be used carefully if at all. The danger of infection is great if a razor blade is used to remove corns. A safe way to remove corns at home is to soak the feet in warm salt water and rub away the excess skin with gauze.

A bunion is an enlargement or dislocation of the big or little toe joints which is generally accompanied by inflammatory swelling. Short shoes, shoes with excessively pointed toes, or short hose are basic causes of this condition. Two methods are used in the treatment of bunions; namely, manipulative treatment by a chiropodist or a podiatrist and surgical treatment by an orthopedist. Surgical treatment is generally a last resort.

The careless cutting of nail edges is the most common cause of ingrown nails. However, shoes or hose that are too short or tight often cause this trouble. Feet with ingrown nails should be bathed in warm water containing some tincture of green soap. The insertion of some cotton or gauze between the nail and flesh is beneficial. Liberal use of germicide is needed to forestall infection. For permanent relief one should wear shoes and hose that are sufficiently wide and long and cut nails straight across.

It is unfortunate that the gymnasiums of some public schools contribute to the spreading of interdigital ringworm—commonly known as athlete's foot. Authorities estimate that 50 per cent of the population suffer from this foot skin disease. Athlete's foot is caused by a plant parasite (*Tinea Trichophyton*) which is a distant cousin of the well-known bread mold. It is generally acquired by walking barefooted over surfaces contaminated with the germ. The best guarantee against acquiring the infection is to use bath slippers in all dressing rooms. In the treatment of athlete's foot, it must be kept in mind that the causative microorganism buries itself beneath several layers of skin; hence, in order for a medicine to contact and kill it, that medicine must first disintegrate the protecting layers. Many preparations of an antiseptic nature may be purchased at drug stores to apply to the infected areas. They are usually effective but painful. Doctors use X-rays and ultraviolet rays effectively. It is essential that only sterilized hose be worn during the period of medical treatment in order to prevent reinfection.

The foregoing discussion of common foot ailments is not all inclusive by any means. A review of the medical literature would reveal much more information. Many common foot troubles, such as papilloma, frost bite, club nails, and blisters, were not mentioned. It is hoped, however, that this limited discussion will serve as a stimulus to further investigation. In order to facilitate further study, a bibliography has been prepared. The references are not arranged alphabetically but according to the amount of aid that they would give to a biology teacher in preparing a unit on foot health.

1. *Care of the Feet*, published by the Frederic J. Haskin Information Bureau, Washington, D. C. Price ten cents. Prepared by the National Association of Chiropodists and Podiatrists and the National Foot Health Council.

2. Hiss, John M., *New Feet For Old.* Doubleday, Doran and Company, Inc., New York City, 1934.

3. Bellows, Jane, *Feet and Shoes.* The Womans Press, 600 Lexington Ave., New York City, 1928.

4. Write to the Orthopedic Shoes Inc., Portsmouth, Ohio, for the five following

charts: Flat Foot vs. Normal Foot, The Danger in High Heels, Points of Body Pain Due to Incorrect Shoes and Flat Feet, Essentials of a Well-fitting Shoe, and What Wrong Types of Shoes Will Do to Feet. These are free to teachers.

Importance of Field Work for the High School Biology Teacher[1]

HOWARD H. MICHAUD
North Side High School, Fort Wayne, Indiana; Chief Naturalist, Indiana State Parks

The high school biology teacher interested in his subject is constantly seeking new methods of approach, carefully weighing objectives, searching for inspirational material, both for himself and for his students. Field work and outdoor guidance as a part of the biology course offers one of the most valuable means of motivating both the teacher and student in the science of biology.

In order that field trips may become a successful part of the biology course, the teacher himself must become imbued with a desire for some original observation and investigation in natural science. There are those no doubt who feel that the high school teacher has lost the opportunity for original investigation. Frequently, a mere suggestion of an interesting problem afield quickly dispels such a notion. "Opportunity for Investigation in Natural History by High School Teachers," reprinted from the Journal of Michigan schoolmaster's club, 1933, is a bulletin which furnishes the teacher precisely the kind of suggestions needed for the development of his own biological interests in the field. One statement by H. H. Bartlett is particularly worthy of consideration; "The best teachers are the ones whose careers appeal to the pupils as interesting and worth emulating."

The teaching of biology is not intended by any means to direct all students into biological occupations. However, there should be developed in all pupils a sense of appreciation for scientific research, a scientific tolerance for all knowledge, an appreciation for the out-of-doors and an ability to adjust themselves to their immediate environment. If field trips awaken students to the recreational advantages of the out-of-doors, the biology course has served a most beneficial purpose.

There is no means of fully evaluating the importance of field work to the teacher in the secondary schools. The gains derived will lead not only to greater recognition but will certainly enhance the success of the teacher in the classroom. Those who do not possess this background are usually not teaching biology with the enthusiasm of the leaders of science. Perhaps they are finding no joy in their chosen life's work, because their approach to the problems of teaching are not, for them, the most natural and effective.

There are in Indiana two high school biology teacher groups affiliated with *The National Association of Biology Teachers*. The Terre Haute area teachers meet monthly. The northern Indiana organization has held three meetings a year

[1] Presented in a Biology Symposium held at Indiana University, July 18–20, 1940.

during the past two years. Both groups, it is believed, represent the outstanding high school biology teachers of the state. Considerable effort has been devoted to programs of field studies by these teachers. It is to be noted that the individual members of these two organizations show a keen interest in developing for themselves a greater knowledge, particularly of the flora and fauna of their own immediate localities.

Whatever the subject may be—taxonomy, morphology, physiology, embryology, genetics, behaviorism, or conservation—there is always much to be gained by a fuller knowledge of how living things exist within their own native habitats. Certain variations of a species within a given locality may be noticeable enough to suggest a problem in either morphology or genetics. The instinctive pattern of behavior of a species in your locality may be so altered as to prompt investigation. What the teacher sees, the student can learn to observe and often help to interpret. Thus do the field studies help to vitalize the classroom procedure.

The Naturalist's program in the Indiana state parks is organized to fit the needs of the average park visitor. First emphasis is placed on recreation, but it is felt that the park visitor benefits in direct proportion to his knowledge of the out-of-doors. Nature museums are maintained as a part of the program. Early morning bird hikes, general nature hikes, and lectures on nature subjects are given to adults and children in group camps. Thus it has been possible to evaluate to a considerable degree the social and scientific benefits which average citizens derive from an increased knowledge of biology. What is true of adults and children in the open must be true of our pupils in the classroom. Out-of-door biology is interesting. Classroom biology should be just as interesting; but oftentimes is not because of a lack of understanding on the part of the instructor.

There are innumerable observations and studies to be made in the field. Much can be said about the value and implications of such studies. Here are a few simple stories from my own experiences afield, illustrating methods which have particularly aroused interest and enthusiasm, from which may be drawn conclusions as to the teaching value of field work for the high school teacher of biology.

We stand before a tree. It is either a butternut or a black walnut. The bark is distinctly zebra-barked, with contrasting white flat ridges and darker sutures. Surely, therefore, it is a butternut tree. But again, in northern Indiana there are many butternut trees on which the bark does not reveal such an obvious contrast. In winter, too, the relationship is not always so apparent. A twig is cut and examined. There is the chambered pith. Is it light or dark? If you know the light tan coloration of the black walnut compared to the chocolate brown of the butternut it is simple to make your identification. Or did you know that above the leaf scar the butternut has a mustache? Old white men have mustaches so it is the white walnut or butternut. Very easy if you know.

During the summer one of the naturalists found a peculiar paper wasp's nest. It looked like a small gourd hung upside down with an opening at the lower end of the neck. He thought it was some new kind of wasp's nest because there was no activity. A few days later, however, peering into the open end of the nest he observed the white grubs hanging upside down, their bodies working vigorously. For the inquisitive naturalist that was a sight worth repeated observation.

In another case, an experienced horticulturist called our attention to a hole about one half inch in diameter alongside a privet hedge which he was pruning. Curiosity naturally prompted us to dig into the hole to find its occupant. About six or seven inches down a large black spider was found. It was probably a member of the genus *Lycosa*, one of the wolf spiders.

Students find their out-of-door experiences so interesting that it does not occur to them that the learning process is involved, and, what is more important, field studies never become a form of monotonous work. A hike was recently conducted with a group of forty 4 H club camp children of high school age. The main object of the excursion was to visit a small cave. To reach the cave it was necessary to climb a steep rocky ravine, starting from a creek bottom, up about one-hundred-seventy-five feet. Since it would have been hazardous to make the rough ascent with so large a group, dislodging rocks as we climbed, only half the group were allowed to climb.

The creek bed was an excellent place for hunting fossils. After the waiting children had been shown a nice example of fossil cup coral, the inquisitive spirit immediately began to manifest itself. Numerous hands were soon pointing upwards holding rocks. Many questions, too, were asked about these rocks, ten thousand times as old as any civilization. The group below hunted until their turn to climb; and after both groups had visited the chief object of their hike, another hour was spent in hunting fossils. Numerous kinds of brachiopods, bryozoans, and crinoid stems as well as cup coral and compound coral were carried back to camp. So great was the interest, it was necessary to spend an hour labeling diagrams in the students' camp autograph books, so that they might remember the names of their geological specimens.

The foregoing represent rather simple examples and procedures. There are no limits to the possibilities presented by out-of-door field experiences and studies. The amount of research material is inexhaustible. Every high school biology teacher should become sufficiently interested in some problem of investigation to become at least a local authority. There are problems in ecology, mammalogy, ornithology, ichthyology, protozoology, parasitology, and plant physiology which need investigation. Local studies of any animal or plant group may contribute valuable knowledge to the scientists working in specialized fields.

Much of the knowledge gained in natural science through careful research has had its beginning in comparatively simple questions. The solutions can sometimes be achieved through just a bit of careful observation in the field. Are you able to answer some of the simple questions your students may ask? "Into what do the larvae of the white grubs in sod develop?" "How many antennae have the water snails; the land snails?" "Are the new growths of twigs of slippery elm rough or smooth?" "How do the bank swallows and rough-winged swallows differ?" "What birds migrate through your school grounds and at what time of the year?" "What trees in your locality are most affected by the cankerworm?" "What birds in your locality are most typical of your zonal area?" "What warblers nest in your locality?"

There is an abundance of reference material available for all who have an interest in field identification. Nature study books may be classed either as *general* or *specific;* the latter are useful for the identification of specialized flora and fauna groups. General nature books

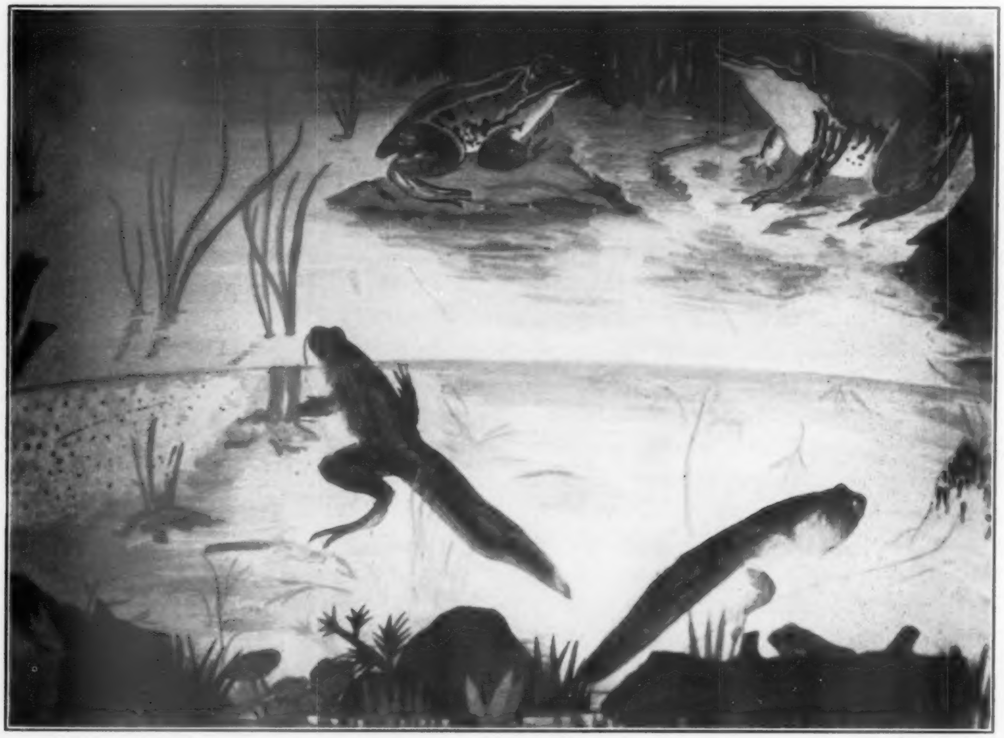
may be used as inspirational material, helpful primarily in presenting methods for encouraging students in field studies. There are field books for nearly every plant or animal group. Many current magazines are beneficial in keeping the teacher informed concerning the whole field of natural history. "Natural History," "Nature Magazine," "Bird Lore," "The National Geographic Magazine," "The Wilson Bulletin," "American Forests," and "Science Digest" are a few that may be mentioned. There are many Journals which are devoted to the more specific flora and fauna groups. United States government publications should not be overlooked. A weekly price list of bulletins may be secured from the United States Government Printing Office for the asking.

THE DIORAMA AS A TEACHING AID

The diorama as a visual teaching aid in biology and other secondary school sciences is rapidly gaining favor with instructors. As a project it is simple, adaptable, and easily constructed; when completed it has a definite vital lesson for each person viewing it.

The diorama combines the effectiveness in perspective of the stereoscope and the esthetic qualities of the panorama. In modern exhibits it has been adapted to present methods of construction, lighting, and display.

For classroom purpose many types of material may be used. Actual specimens, drawings, paintings, and cut-outs



Diorama of life cycle of the frog

are all used effectively in developing particular scenes. Life cycles of plants and animals and their habitat relationships furnish excellent source materials. Scenes constructed to show typical events in the life of great scientists: Pasteur, Koch, Lister, Smith, Darwin, Mendel, and others can be made vivid and lifelike.

The construction of a diorama is quite simple. After a scene is decided upon, a box is made to house the completed picture. The background is usually painted on a curved cardboard that fits into the back of the box, with the ends of the cardboard reaching the front end of the box. This curved piece will vary in size, shape, structure, and texture according to the materials available and the effect desired. Other items consisting of actual specimens or of cut-outs of specimens may be used in the foreground.

The construction of dioramas by students will result in large dividends in the education of boys and girls. By the nature of the project the students are forced to do detailed and accurate work. The completed productions appeal to the esthetic as well as to the scientific sense. In addition to the benefits accruing to the creators themselves the school gradually gains a valuable teaching museum.

WILLIS W. COLLINS,
Idabel High School,
Idabel, Oklahoma

Biological Briefs

SELLEI, JOSEPH. *The Effect of Fluorescent Dyes on the Growth of Plants.* Growth 4: 145–156. August, 1940.

Chlorophyll is a fluorescent coloring material which is regarded by some as a "light catalyzer" for the plant, and it has been found that other fluorescent dyes may render the plant still more sensitive to light. Animals may be sensitized to light by dyes, also. Sheep, fed with buckwheat which contains a light sensitizing factor, soon die. White mice injected with small amounts of eosin become extremely agitated and die if subsequently exposed to sunlight, but if taken to a dark room before they are completely exhausted they slowly recover. In the plant experiments, a very dilute solution of fluorescein was used for watering; concentrated solutions retard development. Of the plants properly treated, many grew noticeably faster; they bloomed earlier, their fruit ripened faster, and the yield was increased from 20% to 100%. Each plant has its own period of sensitivity and will not respond to the dyes at other times. The soil must be well fertilized, for the sensitized plant exhausts the ground quickly. The effect of the dyes was increased by the addition of small amounts of copper and iron salts.

MUNGER, THORNTON T. *The Cycle from Douglas Fir to Hemlock.* Ecology 21: 451–459. October, 1940.

Douglas fir, a very important tree for lumbering in the Pacific northwest, is not a climax species. It grows best in open stands, and does not reproduce in its own shade. As a forest of Douglas firs matures, hemlocks and other shade-tolerant trees creep in and eventually replace the firs. This means that the clearing of overmature forest stands by fires and lumbering has been the main factor in the abundance of this species.

DARLING, J. RODGER. *Miracle on Wings.* Natural History 46: 205–207; 240–243. November, 1940.

The author here gives a fascinating account of the training and racing of homing pigeons, together with a description of other breeds. Many pigeons can travel over 600 miles in a day, and the record homing flight is 7000 miles. Intensive and regular training must be given to young homers, to accustom them first to remain on the wing, and second to return to the home loft as quickly as possible. Racers are timed from the moment of departure from some point about 200 miles away until they enter the home loft, when the owner quickly detaches a tiny capsule from the bird's leg and deposits it in an automatic timing device which is then sent to the judges. The enemies of homers are mainly hawks and hunters; dark colors are preferred because of their lessened visibility while awing. Pigeons mate for life and produce two young per clutch. The eggs are laid 1½ days apart, and the parents delay the incubation of the first egg so that both hatch almost simultaneously. The young mature in four weeks, having been cared for and fed prodigious amounts of food by both parents. All of the present-day breeds have been developed from the blue rock dove (*Livia, livia*) of Turkestan.

Books

HYLANDER, CLARENCE J., AND STANLEY, ORAN B. *Plants and Man.* The Blakiston Company, Philadelphia. 308 ill. 518 pp. 1941. $3.00.

Plants and Man is an introductory text for the survey courses now so popular in our colleges. In language remarkably free from burdensome terminology it presents the fundamental concepts of plants in so far as they are connected with the common problems of human existence. It is not intended to prepare students for further work in biology; rather it is calculated to appeal to the general interests of the average student and convey to him those things about plants which increase his informational and cultural background. Probably the book will serve better in a "text" course than it would in one requiring much laboratory or field work.

The book is made up of six parts of which the first deals mainly with plant structures and the general relations of plants to man. The other five sections discuss cleverly grouped useful or harmful plants. In each section the discussion is preceded by the structural or functional information essential to a proper understanding of the material treated.

The book has an easy style and is adequately illustrated. The wealth of usable information contained makes the book a "must" on the reference shelf of both teacher and student in the high school.

BROTHER H. CHARLES, F.S.C.,
St. Mary's College,
Winona, Minnesota.

GERARD, R. W. *Unresting Cells.* Harper & Brothers, New York. xv + 439 pp. 1940. $3.00.

"The single enzyme molecule, like a preacher, can cause an unlimited number of molecules of the proper kind to unite (or react, or exchange atoms). It can also, like a judge, separate the unions and restore the original status of the molecules." This statement accompanies a diagram showing two rows of individuals approaching a preacher

who unites them without himself being changed in the process. But some of these couples approach the judge (who is the preacher in disguise) and when he divorces their union, they leave as separate individuals again.

Could one want a better, or clearer, or simpler analogy to explain enzyme action? Professor Gerard's book is a storehouse for any teacher in need of such similes. The gradient from the head to the tail of a planarian is compared with an army, from the general down to the buck private; genes are compared to pioneers, who do not carry with them the objects used in civilization, but rather the tools with which to make them; a glucose molecule is compared in structure to a centipede; the difference in chemical structure between ethyl alcohol and methyl ether is compared to the difference between the words "each" and "ache."

All these analogies, and a host of others, make it easier for the reader to understand the complexities of life. For that is what the book aims to do—explain how living things work. It turns out that life is carried on by complex systems of molecules which react according to physical and chemical laws. These systems are basically the same, although they may appear outwardly different.

Although I can not agree with the statement on the jacket of the book to the effect that it is written ". . . in simple language which presupposes no previous scientific training on the part of the student," I do think that a person with some background in biology, chemistry, and physics, can gain a better understanding of what constitutes life by reading *Unresting Cells.*

PHILIP GOLDSTEIN,
Walton High School,
New York City.

BRYAN, ARTHUR H., AND BRYAN, CHARLES G. *Principles and Practice of Bacteriology.* Barnes & Noble, Inc., New York. 410 pp. 1940. Paper. $1.25.

This paper bound book is a revision of the 1938 edition of "Principles and Practice of Bacteriology," rewritten to include changes suggested by teachers and technicians in leading colleges and universities, and some new material.

Informational material and laboratory practice included is in clear concise form, and covers the study of pathogenic yeasts and molds, plant diseases, soil microbiology, dairy bacteria, viruses, pathogenic protozoa, veterinary pathogens, human pathogens and allied organisms. Numerous reference tables and charts summarize at a glance lengthy subject matter.

Review questions are found in the appendix in the form of self-testing achievement examinations, which review the fundamentals of bacteriology. A separate part of the book is devoted to newer phases of the study of serology and immunity. There is a comprehensive glossary and index.

The book is prefaced with a series of attractive actual color views of better known pathogenic bacteria, stained with "Soloid" microscopic stains.

It is primarily a book for use in college classes and schools teaching laboratory technique, but is recommended as a useful addition to the library of the high school biology teacher who includes considerable instruction in bacteriology in his course of study. It would help greatly to enrich and make more accurate and up-to-date the material used in such class work, and would be admirable as a concise reference book for student projects in the field of bacteriology.

B. BERNARR VANCE,
Kiser High School,
Dayton, Ohio.

Youth Looks at Cancer. Westchester Cancer Committee, New York, 1940. 55 pp. $.75. (Special discount to schools.)

Here is a book for secondary school pupils on cancer unencumbered by academic verbiage, devoid of gruesome and scare-producing details. It is straightforward, simple and authoritative. It has been checked by acknowledged authorities in the field of cancer work and pedagogy. It is divided into three parts. Part One deals with history of cancer, its causes and contributory causes, its treatment and diagnosis. Part Two discusses common locations of cancer and Part Three develops suggested activities, available visual aids and references, materials, a pupil's catechetic approach to information on cancer, the science teacher and cancer information, and a very thorough annotated bibliography for secondary school pupils.

It is a hard covered $5 \times 7\frac{1}{2}$ inch book that can take long wear. It is a photo-offset printing supplemented by well-executed photographs with worthwhile didactic legends.

ALAN A. NATHANS.

WEIMER, BERNAL R. *Nature Smiles in Verse: A Collection of Bi-illogical Poems.* (Distributed by the author, Bethany College, Bethany, W. Va.) X + 99 pp. 1940. $1.50.

So, naturalists observe, a flea
Has smaller fleas that on him prey;
And these have smaller still to bite 'em;
And so proceed, ad infinitum.

Thus wrote Jonathan Swift in the 18th Century; and in similar vein have poets —professional and amateur—been writing about plants and animals, on down to our own time. Dr. Weimer has collected and published an amusing assortment of humorous verses on biological topics, including several of his own. *The Dinosaur* by Taylor and *The Centipede* (Anonymous)—with which many readers are familiar—are included. Philip Pope has two: his poem *Amphioxus* is especially good. By way of preface the author and compiler writes: "No apology is offered for the contents of this little volume. Life is serious enough, and teachers often more so. If this collection will make the dry dust of scientific facts less choking, and put some life in 'academic dry-rot,' it will have served its purpose. If it keeps us all from being overly serious and unduly dignified, the risk has been worth it. If it does none of these things, it is your fault, not mine!"

E. C. C.

COLIN, EDWARD C. *Elements of Genetics: Mendel's Laws of Heredity with Special Application to Man.* The Blakiston Company, Philadelphia. xii + 386 pp. 1941. $3.00.

In the preface it is stated that this book is designed especially for college students although it is hoped that the large amount of material on man will make it of interest and value to the general reader.

The chapter headings are as follows: Mendel: Student, Priest, Teacher, Investigator; Dominance and the Law of Segregation; Dihybrids: The Law of Independent Assortment; Chromosomes and Mendel's Laws; Linkage and Crossing-over; The Rediscovery of Mendel's Work; The Factor Principle: Action and Interaction of Genes; Heredity in Man (2 Chapters); Sex Determination and Sex Differentiation; Sex-linked Heredity; Heredity and Environment; The Gene and Mutation; Inbreeding and Crossbreeding; Heredity and Evolution; Improvement of the Human Species (Eugenics).

The historical approach has been

adopted as the one most likely to gain the interest of the beginning student; historical references are included in each chapter.

Citations of authorities are given. The book is illustrated with drawings and diagrams (largely original) and halftones. Problems are grouped at the ends of the chapters.

There is a nine-page *Glossary* of terms most commonly used in Genetics and an *Index* of authors and subjects.

A Functional Program of Teacher Education, as Developed at Syracuse University. American Council on Education, Washington, D. C. 260 pp. $1.25, paper.

This book was written by the Curriculum Committee of the School of Education at Syracuse University. It contains a description of the program developed at Syracuse for the selection, training, and placement of secondary school teachers. It should be of interest to those in other institutions who are engaged in a similar enterprise.

Nomination for Membership
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Please fill in blank below or write out on separate sheet and mail to P. K. Houdek, Secretary-Treasurer, Robinson, Illinois.

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I nominate .... of the

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for membership in the National Association of Biology Teachers, which includes subscription to the American Biology Teacher.

(Signed) ....

(Address) ....

MR. P. K. HOUDEK, *Sec'y-Treas.*, Robinson, Illinois ☐ NEW ☐ RENEWAL

I hereby apply for membership in *The National Association of Biology Teachers* and enclose $1.00 as my annual membership dues, 80c of which is for a year's subscription to THE AMERICAN BIOLOGY TEACHER. (Subscription may not be had separately)

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